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## **A Tale of Training Superiority, Games, and People Stuff**

When I attended DARPA Tech 2000, I was a contractor. I was also writing the report of a Defense Science Board task force: Training Superiority and Training Surprise.

In the hotel room, late at night, the writing was not going well. I needed more actionable recommendations. I was tired. I was annoyed. I knew that I was going to sleep through the next day's sessions. So, in a fit of pique, I decided DARPA was gonna pay! I wrote that they should create a new office for high-payoff people technologies: the Training and Human Effectiveness (THE) office in DARPA.

Three days after 9/11, I was offered the chance to demote myself from DSB Task Force Chairman to put my (and DARPA's) money where my mouth was. So today there is an office in DARPA exploring the unintended training consequences of military transformation.

Our program takes the training out of the four-letter word category and lets everybody train cognitively any time, any where.

The program is based on three DSB findings: 1) People are as important to proficiency as hardware. But hardware research and acquisition get all the money. 2) In our transformed military, everybody must think. Today, we are asking everyone to do things that 10 years ago we would have assigned to Special Forces. 3) Our forces don't have enough opportunities to train. The 1970s and 80s saw a revolution in military training exemplified by the National Training Center where brigade-sized units improve by an order of magnitude in 2 weeks. But

units have access to this revolution, at best, every few years.

In response to these findings, we have created a training superiority program nicknamed DARWARS for DARPA's universal, persistent, on-demand, training WARS. We address the problems our forces don't have the time, money, or facilities to train, and that we can't train with show stopper problems like electronic or mine warfare.

Even with my DARPA-issued ego, I knew we couldn't take on all DoD training, so we chose to exploit existing PC hardware to teach cognitive lessons. DARWARS won't teach you how to drive your 10-ton truck through narrow urban streets, but we will teach you to look up when you do. DARWARS won't teach a pilot stick-and-rudder skills, but it will teach her how to communicate with and support an inexperienced forward observer.

There are a number of ways to frame the DARWARS program, which comprises mostly examples of nontraditional kinds of training. In this paper, we look at the dimension of how many trainees are involved; we will start with training for single users and move on to training to training for teams and teams of teams. There are other ways to sort the problem, which show the limitations of our program.

Learning research shows that with single learners human tutoring instructs 2 sigma better than classroom teaching. Unfortunately, good tutors are rare. In our IT training project, using Unix system administration troubleshooting as a test case, we bypass an expensive knowledge acquisition

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bottleneck. We capture real student/teacher interactions and port that knowledge to an interactive digital tutor. Our new tutor not only delivers the 2 sigma effect, but we believe the next tutor will be inexpensive, paying for itself with the travel savings from two classes that learn at home station.

The next single-learner piece of DARWARS challenges the dogma that language is only for linguists. In 2 discontinuous weeks, we put a little tactical language, gesture, culture, and mission-oriented vocabulary into the brain behind every trigger finger and every steering wheel, so no American fighting person will again have to ride blind into a foreign culture.

To keep the foreign language-impaired student engaged in this daunting task, we incorporated a computer game into the very core of this PC software. You mouse your character up to a synthetic Iraqi civilian, take off your virtual sunglasses, dial a polite gesture, and engage the speech recognizer with the right mouse button. (If you hit the left mouse button, you're told "you can't shoot in this game, you have to talk your way out."). If you say "As salamu 9alakum" (the "9" indicates a voiced Arabic "H" sound) well enough, the character responds with the same polite gesture,

"Wa halekum is salam." This is surprisingly satisfying; make strange noises into a microphone and screen characters respond!

But it is not only about the words. If you don't pay attention to gesture and culture, you can get into trouble. Forget your Iraqi manners, and a synthetic onlooker stands up to ask (in Arabic) "Who you are really." When you respond "iHna Amerikan," he asks "CIA?" which is Iraqi for "CIA?" And your digital aid says, "We blew it. Let's get out of here."

You practice the words needed for the mission in a "skill builder." It doesn't just tell you whether you pronounced a word correctly. Having collected all the ways ordinary Americans mangle Arabic, we tell you how you mispronounced it. If you say ARE-EEF for "sergeant" your digital aide says, "You didn't roll your 'r.' That's hard for Americans, but give it a try. Lets hear that flutter, 'arrrrriff.'"

We even have a PacMan-like arcade game (bonus points and all) to teach directions, colors, and geographical terms.

We have no reports yet from Iraq returnees, but a beta tester said, "I learned more in 1 day with this than I did in a whole tour in Iraq." In May, we started building a tactical Pashto trainer.

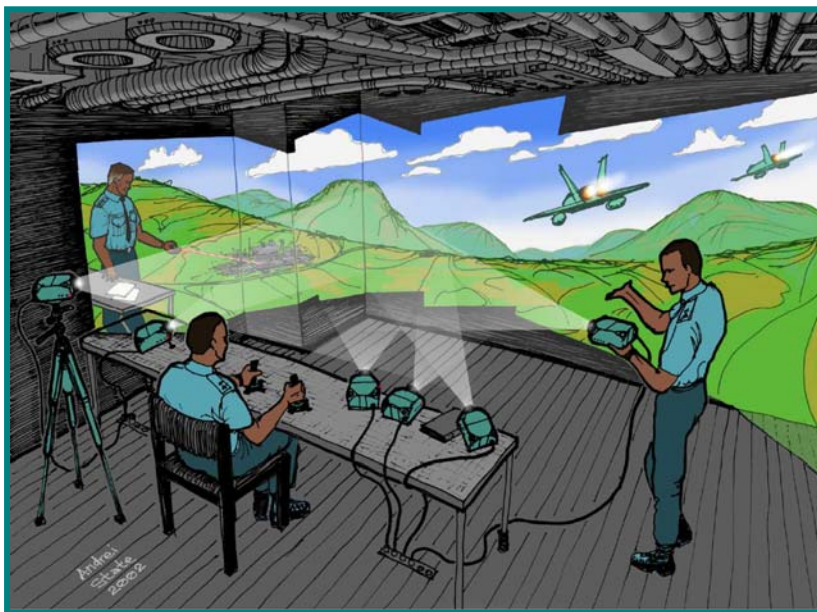


Scene from Tactical Language Trainer

The next project, Synthetic Teammates for Real-time Anywhere Training and Assessment (STRATA), trains up to four pilots while shrinking air-to-ground mission training from a hanger-sized affair into a seabag that we can smuggle onto aircraft carriers. The key to this approach is synthetic teammates; some wingmen, some forward observers. We created a cognitive model for each teammate that passes the Turing test in this limited domain; they are so good that humans hearing the action can't tell which pilot is real and which is synthetic.

Supporting this cognitive training is a small effort with large implications for

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*Aircraft Carrier Ready Room*

low-cost, compelling, large-area displays. Projecting a simulation onto an arbitrary shaped space, such as a tent, results in highly distorted images, especially at the corner. A camera, however, can help the system recognize and correct those distortions. If we add a few more projectors and create software to correct for overlaps, color, and dynamic range distortions, we expect to deliver a “dome in a tent” or, as in the figure, an aircraft carrier ready room.

At the level of training for everybody, we are creating architecture to tie disparate training systems together: to punch holes in the stovepipes of the cottage-industry training world. Architecture is hard to comprehend and even harder to get people to buy into, but it is vital for universal, persistent, anytime training.

In its simplest sense, DARWARS wants each training system to be “aware” of the other. An early DARWARS joke was, “Sure Chatham’s programs will work together. The pilot will crash his plane in virtual Afghanistan and be able to tell his captors in tactical Pashto, ‘Don’t shoot me, I can fix your IT systems!’”

Actually, that is a good example of how DARWARS should work; the pilot who crashed virtually, discovers, while he is still thinking about

being captured, that he can obtain some basic language skills.

Demonstrating a higher level of training interoperability, we connected a Microsoft flight simulator to the training game Fleet Command. The plane flew across the command-level screen as an icon, flew through an Army training game, and dropped its bomb on a forward-air-observer trainer, pulled up, and flew back out to sea. DARWARS tools will make it easy for more training systems to join.

Our architectural effort identified a hole in our spectrum of challenge projects of training at all scales of users, so 9 months

into the program, we filled in the multi-user trainer gap while rising to Dr. Tether’s challenge to help our troops now. The result is DARWARS Ambush, a PC game based, squad-level, multiplayer, lessons learning trainer we developed and delivered to Iraq in 6 months. They are learning how to prepare for and deal with a convoy ambush. Most of them are about to be ambushed. A few others will deliver the ambush. Either way, they all learn. We also provide tools for them to create new scenarios so users at Fort Lewis are mining lessons learned and creating training for new tactics, techniques and procedures without a contractor in the loop.

One Airman wrote, “I was in an ambush last year. This is as close to real as you can get without being in danger.” The Air Force has just added ambiguous scenarios to Ambush! to teach rules of engagement. The Army is using it to help train those afflicted with posttraumatic stress disorder to manage their fear.

Where are the holes in the DARWARS vision? First, when we were starting DARWARS, everyone wanted a way to practice for urgent, unexpected contingencies, what I call the “instant mission rehearsal” problem. It involves extracting geographic, cultural, and military data from disparate sources, combining them into a virtual



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world within which our forces can practice, and building training packages so they learn, not just wander around as you might in a computer game. And all this must be done in days, maybe hours, but we certainly cannot take years to develop training applications, as is the case now.

I didn't know how to solve this, so DARWARS' answer to prepare our forces for the unexpected was to provide the opportunity to rehearse a wide range of missions in the hopes some of that practice would apply to whatever reality they would be faced with. Today I do know how to start on this. In fact, we created a whole new office in DARPA to seek this Holy Grail.

Dan Kaufman's approach starts by avoiding a costly mistake of the past: we will not try to create software that is all things to all people. Dan intends to develop an 80 percent solution that emphasizes creating tools ordinary users can employ to create their own mission rehearsal and then demonstrate how to use them with a few examples called "accelerators." To start, we'll need real-terrain data, high fidelity for some users, especially close to the military action, lower fidelity for others. Manipulating and updating such information in real-time presents a great challenge, especially after simulated air support changes the terrain.

That is already hard, but it's even more difficult to supply information about what's inside the building. Nor can we tolerate that annoying graphic that says "LOADING... please wait" when you move from outside to inside. The entry must be seamless.

Current computer games can't handle large numbers of entities in the same place, entities that must behave realistically, not only physically but culturally. Moreover, we cannot be seduced into pixels for pixels' sake. The simulation must be good enough and no better, where good enough may vary from one user to the next, within the same rehearsal event. We must be able to scale all this from a few entities to thousands, seamlessly.

The computer game industry can't solve these issues; for them, the underlying game engine defines reality. We have to make reality define the engine. The basic visual representations of a door and a concrete wall are the same, but in real life a bullet will go through one and not the other. It is real lives we are dealing with. It's harder than that, even, for Dan's world can't be just a simulation; it must be a training tool. This is a DARPA challenge.

We hope to automate the process that DARWARS Ambush! users at Fort Lewis are performing manually today: take the mass of mixed media lessons pouring in, use them to create instant digital training scenarios, and export them directly to users. But we don't know how to measure an individual's or unit's current needs and create new scenarios to match.

We hope to exploit team communications to create a real-time performance alarm; a cockpit light that indicates, "You are talking nonsense. Abort the landing and try again!" But we can't yet create a digital "old crusty" who will tell a battle commander, "This same thing happened in 1902. Would you like to know how that turned out?"

Military simulations have "physics engines" that calculate how objects behave in the real world. But we don't know how to create "people engines," with cultural plug-ins to do the same thing for individual and crowd behavior.

There are more gaps. Some we know about; some we don't know. DARPA works only when people and organizations help us identify those gaps, in this case, those unexpected and unintended human consequences of transformation. We need your help to show us how to build ladders so our forces can climb out of this mixed metaphor, this technology pit. They are doing a superb job with what we have given them. They deserve better.

Mark Twain wrote that being a Mississippi riverboat pilot stood him in good stead as an author, because every personality type he subsequently

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encountered he already knew; “I met him on the river.” In the same way, with your help, this new human transformation vision will make our forces able to meet the unexpected challenges of future conflicts. They will have fought them before in DARWARS.